INDUSTRIAL INTERNET OF THINGS

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INDUSTRIAL INTERNET OF THINGS

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OVERVIEW

Connected machines will create better jobs

Negative stories have surrounded the internet of things and job losses have been their focus, but a more accurate analysis reveals a shift in the skills needed towards services

LEO KING

The internet of things or IoT, which can connect any device to the web, has been a boon for owners of manufacturing firms. By providing data from multiple machines, factory performance can be monitored, goods can be tracked and maintenance needs predicted – all for greater efficiency.

Those on the factory floor have been less supportive of the change, understandably fearing their jobs will be replaced by robots and machines that "speak" to each other.

The reality, however, is more nuanced. Rather than eliminating all roles, the IoT is creating demand for a different set of skills. Many of these jobs will come from the service sector, supporting customers, and also the technology sector that supports the systems.

By 2020, according to the Centre for Economics and Business Research and technology firm SAS, some 182,000 jobs will be created in the UK by the IoT and big data in a range of areas.

The IoT allows traditional product businesses to become services firms. Instead of simply manufacturing and selling goods, the industry can now maintain and upgrade them, something the technology sector rather awkwardly labels "servitisation".

IoT-connected devices link consumer goods to manufacturers' systems, advising of maintenance and upgrade needs, the same way factory devices are connected. Washing machines or heating control systems, for example, can be fitted with sensors to detect when they are going wrong, alerting manufacturers to send an engineer. The same concept can be applied to the business world, and to a water utility's pipes and control systems.

Numerous predictions demonstrate the enormous services opportunity. Gartner expects 8.4 billion IoT-connected devices to be in use worldwide this year, with 5.2 billion of them in consumers' hands and 3.2 billion of them in businesses. Some $1.2 trillion will have been spent on IoT by 2020, says analyst IDC, with manufacturing leading the way last year with a cool $187 billion.

The change creates demand for a raft of new talent. "To capture the bigger opportunities presented by the industrial IoT," according to management firm Accenture, "companies will especially need to look for skills in data science, software development, hardware engineering, testing, operations, marketing and sales."

Chris Ratcliffe/Bloomberg via Getty Images

Rolls-Royce's IoT systems notify the engineering company when maintenance and upgrades are due

The smartest firms have recognised this shift. Among them is General Electric, whose chief executive Jeff Immelt says industrial companies are "in the information business whether they want to be or not".

The most positive aspects of the new service model are that it provides a deeper customer relationship and a reliable revenue stream for manufacturers. Goods makers can record customer details from which to develop loyalty and they can look forward to recurring service revenue, repairing the devices themselves or taking a cut of their contractors' income.

Home and heating management from the Google Nest and British Gas Hive systems accumulate user data, becoming increasingly invaluable to people as they link automated services to recorded habits, making a brand switch less appealing. For their makers, both data analysis and marketing skills are essential.

This thinking is being taken a step further by expanded teams of marketing and technology personnel, who are using the IoT for immediate promotions. Drinks maker Pernod Ricard has fitted sensors to bottles that enable smartphone users to simply tap their device on the vessels to reveal recipes for cocktails and ways to buy more products. Competitor Diageo designs and runs internet-connected bottles so users can share their own videos.

An entire workforce will grow to create, sell and support the new business. In addition to sales and marketing, Accenture notes in its research, new employees "will include product managers, software developers to create and test new information services, hardware designers to develop the products, data scientists to create and interpret analytics, and user-interface and experience designers".

Business buyers are adding to the scale of these skills demands. Rolls-Royce and General Electric have manufactured jet engines that can be sold as a service, rather than simply a product. Packaged into regular costs for airline buyers are maintenance and upgrades, with IoT systems telling them when to take action. Meanwhile, Michelin uses sensors on customers' delivery trucks to help human experts suggest more efficient travel and sell tyres based on the number of miles driven.

As these services become the key proposition for sales forces, manufacturers can use them to drive uptake of add-on or upgrade products. The data from all of these services can also be applied by expanded research teams to influence fresh product design.

As businesses move their humans away from manual tasks, workers will equally be required to operate, design, monitor or service the IoT-linked machines they have purchased. Then there is the new demand for staff educators to help them use the systems and process engineers to make sure they fit properly into existing operations, Accenture notes.

Of course, with all these systems connecting business networks to the wider internet, security personnel will be paramount. Gartner expects that the "scarce" IoT security specialists will be in ever-higher demand and figures from freelance database Upwork show a 194 per cent increase in 2015 in demand for security infrastructure specialists.

While the IoT may reduce the need for some manual jobs in factories, it will also create a huge new demand for service skills to maintain, create and market the systems. There is no doubt that such a colossal shift will be uncomfortable for some, but the power of people will remain strong in the new world.

3.2bn
of the 8.4 billion IoT connected devices are for business use

$1.2trn
will have been spent on IoT by 2020

$187bn
will have been spent on IoT within manufacturing by 2020

Gartner/IDC

INDUSTRIAL ANALYTICS

Choosing the right model for industry


Buena Vista Images/Getty Images

Trains have on-board edge processors to optimise fuel usage, but incorporate cloud-based predictive maintenance to aggregate information with other trains

Industrial companies face a difficult call when deciding the best model for dealing with, analysing and acting on the plethora of data in the industrial internet of things

BEN ROSSI

For many people, getting stuck in a lift is their worst nightmare. But thanks to the internet of things (IoT), it could be a thing of the past.

German manufacturer ThyssenKrupp, which runs more than a million elevators around the world, is using intelligent IoT algorithms to predict when a lift is about to breakdown and then prevent it from doing so.

The IoT is driven by the ability to make any object a device by attaching sensors to it and connecting it to the internet. The devices are then able to communicate with each other to improve processes.

"Businesses need to find a way to keep up with the rapid pace of change that 21st-century life brings," says Andreas Schierenbeck, chief executive at ThyssenKrupp Elevator. "IoT systems that are integrated into industry in an intelligent and practical way can provide the solution to this challenge."

Connecting and carrying out analytics for more than a million elevators requires an enormous amount of computational power. ThyssenKrupp uses cloud, where computing resources are delivered over the internet on a pay-per-use basis.

But cloud is just one of three prominent models, the others being edge computing and fog computing. Choosing the right one can define the success or failure of any IoT project.

Edge computing is the opposite of cloud, processing and storing data at the data sources themselves. It uses local processing power and storage to carry out low-level, low-value tasks based on the data it is collecting, such as switching things on and off or sending alerts based on trigger events.

Analyst firm IDC predicts that by 2019, 45 per cent of IoT-created data will be stored, processed, analysed and acted upon close to, or at the edge of, the network. "If we want to capture the opportunities of the industrial IoT, it's not enough to rely on today's big central data centres and clouds," says Colin I'Anson, chief technologist for IoT at HPE.

Fog is the middle ground. It computes at the edge but includes elements of aggregation with local resource pools in close proximity to end-users. Devices act as gateways by using distributed nodes linked to the cloud, sending and receiving data and additional compute power when needed.

Rentokil Initial, a pest control company, is harnessing fog computing to connect its rodent containment devices to gateways that collect information and trigger alerts to technicians when the devices need to be emptied or serviced.

These gateways are also connected to a cloud-based command centre where employees and customers can analyse data relevant to them. The company works with software firm Qlik to visualise that data, making it easier to act on.

Another example of fog is the use of blockchain as a decentralised distributed system for device and data provenance. "This is not edge computing as it refers to the whole system state and not cloud as it is not held on one server," says analyst Ian Hughes of 451 Research.

> Cloud, edge and fog each come with their own advantages and disadvantages

Cloud, edge and fog each come with their own advantages and disadvantages. For all the scalability and flexibility benefits of cloud, security is an enduring concern when data is handed over to a third party. Edge ensures only useful data is sent over the network, but it can get costly when more powerful devices are required to cope with extra processing. And while fog optimises the amount of data that is sent across the network, deploying more intermediate processing increases the burden of managing it.

However, industrial organisations shouldn't see any of the models in anyway exclusive; each is appropriate to different deployment scenarios.

A smart city lighting project, for example, requires a more centralised system, while an oil refinery will have lots of edge processing for parts of the process, but an aggregated, cloud-based digital twin representation of the entire refinery.

A train may have an on-board edge processor to optimise fuel usage as it travels, but incorporates a cloud-based system to apply predictive maintenance to tracks to aggregate information with other trains.

"For simple localised monitoring, you could just send the data to a local device to process it," says Gary Barnett, head of enterprise advisory at analyst firm GlobalData. "In more complex environments, like facilities management, the data may be sent to an intermediate server on your site so you can manage it locally, with alerts or aggregated data sent to the cloud."

There is no one size fits all. "The best solution may involve a combination of all three approaches," says Graeme Wright, IoT director at Fujitsu UK and Ireland.

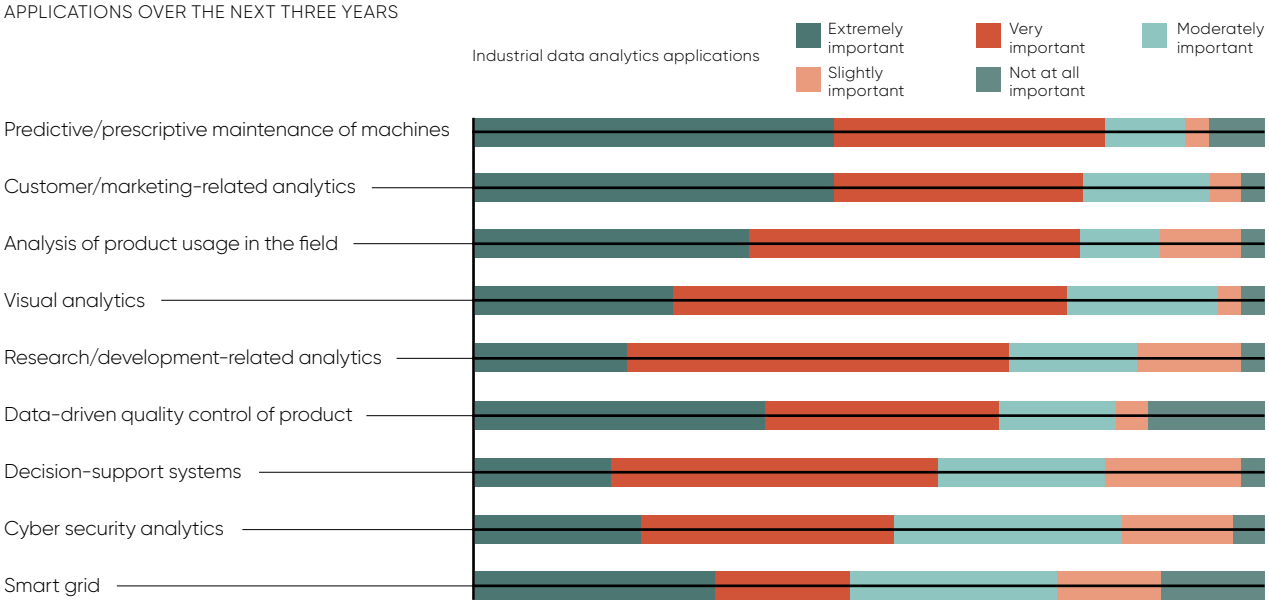
American conglomerate General Electric is a good example of a company deploying all three models. Its industrial internet platform syncs with every physical device to create a complete continuum from assets at the edge to gateways in the factory and all the way to the cloud.

Applying this approach has driven productivity increases of up to 20 per cent in GE's factories, resulting in $730 million in productivity gains in 2016 alone. The company is aiming for an additional $700 million in 2017.

"The cloud plays an essential role in the industrial internet of things," says Deborah Sherry, general manager at GE Digital Europe, "but it's not enough on its own for industrial companies looking to optimise their assets and operations."

INDUSTRIAL DATA ANALYTICS APPLICATIONS

ANALYTICS PROFESSIONALS AND DECISION-MAKERS IN GLOBAL INDUSTRIAL COMPANIES RANKED THE IMPORTANCE OF THE FOLLOWING APPLICATIONS OVER THE NEXT THREE YEARS



IoT Analytics/Digital Analytics Association Germany 2016

COMMERCIAL FEATURE

Good vibrations: how the industrial internet of things is creating the 'intelligent train'

Vibration in train bogies has always been regarded as a problem to be managed. Now a new technology is harnessing it to provide a self-powered monitoring system bringing improvements in cost of ownership, reliability of service and safety enhancement

perpetuum

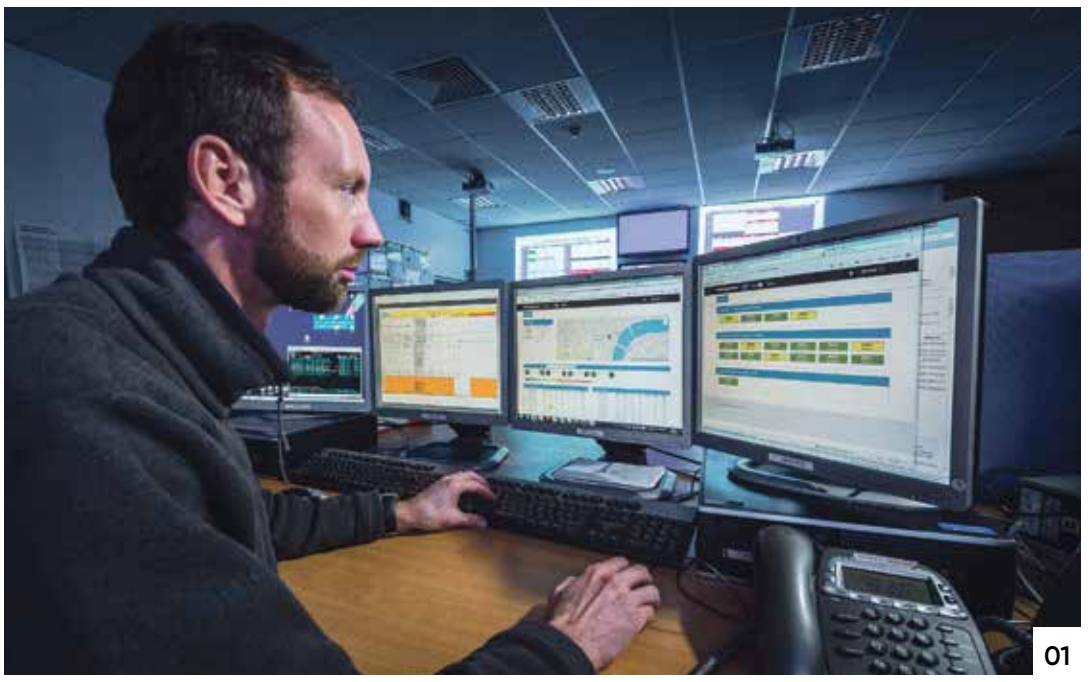
Even a casual glance at recent newspaper headlines reveals how pressures on the UK rail network are increasing. Office of Rail and Road figures show the number of passenger journeys on franchised rail services in Britain increased by 69.5 per cent between 2002 and 2015. Meanwhile, train companies are under growing pressure to manage costs, increase reliability and ensure they get maximum usage out of all of their assets.

Modern trains are complex pieces of equipment and even a small fault can bring them, and a large part of the entire network, to a grinding halt.

Most current rail maintenance regimes are mileage or time based, which means maintenance is done regardless of condition, resulting in both massive waste and unpredictable breakdowns. With condition monitoring, train operators can do maintenance only when necessary. They're not risking being caught out because damage is reported in real time before it causes danger or delays. In other words, they get no surprises.

Now innovative British company Perpetuum has developed and implemented a new technology that can exploit a key feature of the industrial internet of things (IIoT) to provide this kind of constant, real-time "in-flight" monitoring and diagnostics. An approach that's already commonplace in aircraft can now be transferred to trains.

"It means that the train operators don't have any unpleasant surprises caused by key pieces of equipment failing or wearing out unexpectedly because the system predicts outages," explains Dr Steve Turley, chief executive of Perpetuum, a business which was spun out of Southampton University and has developed award-winning, self-powered monitoring systems for both rolling stock and track.



01

02

01 Perpetuum delivers clear, actionable information to enable improvements in cost of ownership, reliability of service and enhancement of safety

02 Southeastern has deployed the Perpetuum system across a number of fleets since it pioneered the innovation five years ago

An exceptionally important feature of the system is that it uses the vibrations in the train to generate enough power for the sensors, microprocessors and wireless transmitters. So it's very simple, low cost and quick to install in minutes with just a few bolts.

Perpetuum has shipped many thousands of its sensors globally and its clients already include six UK rail operators. It has three elsewhere in Europe, three in North America and one in Australia, with many more globally placing orders.

As Dr Turley explains, if a train operator is constantly kept informed about the trains' condition, it can identify and plan any maintenance requirements ahead of time. The system monitors key components such as wheels, bearings, gearboxes and now the track itself. As a result, "in-service" failures can be more or less eliminated leading to better safety and reliability, and lower maintenance costs for trains and track.

It gives operators the ability to do what Perpetuum describes as "maintain on condition". Dr Turley says: "If the maintenance team of a train operator knows what condition a train is in, they don't waste time and money putting it through an unnecessary upkeep and repair programme. 'Condition-based maintenance' means that trains spend more time on the track, improved customer service and increased profitability of the train operator."

This "intelligent train," overcomes another key challenge facing train operators of balancing essential safety requirements with the need to remain commercially viable. Now they can improve both as one leads to the other.

Key to Perpetuum's success is its expertise in vibration engineering. "We're using the vibration to power the smart monitoring of that vibration. Vibration is something that happens naturally with trains, but we've developed technologies that can take this hitherto ignored by-product of a moving train bogie and use it to develop valuable, actionable information," explains Dr Turley.

For example, if a defect is developing in a physical system such as a train, it will create a specific vibration signature, which Perpetuum's technology can identify and isolate from all the other vibration going on in the background. The company calls this "information from vibration".

Exploiting the IIoT's key features of connectivity and reduced need for human intervention, this data is turned into clear actionable information about the "health" of the train on a daily basis by Perpetuum's software algorithms, which alert train operators of impending problems many months in advance. "As a result of this very early warning, we've never had a failure in service for the components that it monitors," says Justin Southcombe, Perpetuum's commercial director.

Perpetuum is unique among players in this sector in that it's vertically integrated. "Most IIoT developers extract information from other people's data, but we have the hardware – that's sensors – plus the communications, software, algorithms and the information display. This knowledge of the complete systems means we can deliver better information in a more co-ordinated, more cost-effective manner," he says.

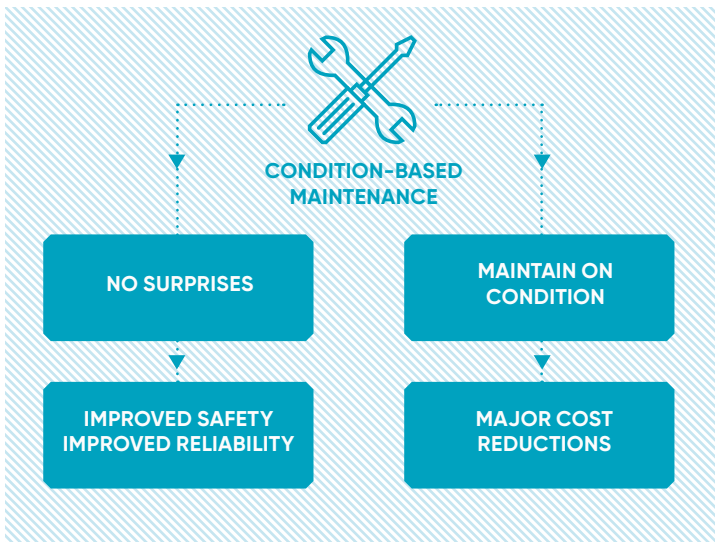
> We're using the vibration to power the smart monitoring of that vibration

Another aspect of Perpetuum's technology that appeals to its customers is that its patented sensor nodes are powered by the company's proprietary energy harvesters, which convert the ambient vibration from a train into electrical energy, known as "power from vibration". The absence of batteries and their issues of replacement and disposal make the sensor nodes more environmentally friendly. Customers love this approach as it makes the sensor system very easy and fast to install without wiring, and the system maintenance free.

"All communications are completely wireless. Wires aren't a good mix with bogies because they get in the way and can become disconnected because of vibration. That means the signal becomes an intermittent and unreliable data source. People like the fact that what we offer really is a 'fit-and-forget' self-contained solution," says Mr Southcombe.

With all these advantages for cost-saving, increased reliability and safety, plus improved green credentials that Perpetuum is already delivering for its customers, it's not surprising that more and more rail operators around the world are selecting Perpetuum's groundbreaking vibration condition monitoring system. IIoT benefits are best achieved with sensors that are self-powered. Perpetuum achieves this and does it on a mobile platform.

For more information please visit perpetuum.com



FIVE TOP APPLICATIONS

Minute sensors like dust and squadrons of drones

The industrial internet of things is poised for take-off and will be given trajectory by innovative ideas. Here are five of the best

FINBARR TOESLAND

The growth of the internet of things (IoT) is drastically changing how consumers interact with their cars, homes and appliances, but the aptly named second digital revolution has major implications for industry too. From machine-learning, machine-to-machine communication to artificial intelligence, the industrial internet of things (IIoT) takes IoT technologies and directly applies them to industrial concerns and in the process improves efficiency and productivity.

While consumer-focused IoT solutions have dominated headlines in recent years and the relatively long life cycles of industrial equipment has limited growth in this sector so far, major firms and manufacturers are beginning to embrace IIoT on a big scale, attracted by the opportunity to drive down costs and increase competitiveness.

Developments in the IIoT environment over the next few years can be expected to increase adoption further, leaving few companies ignoring its future, with a survey by software company Infor finding that 52 per cent of manufactures believe IoT is a priority for their business.

SMART DUST

1

The concept of tiny sensors the size of a grain of sand, with the ability to detect everything from chemicals to vibrations, was first thought up in the early-1990s, but little progress was made in the following years turning this intriguing idea into a reality. However, interest in this nascent technology has grown recently, with research firm Gartner predicting smart dust will trend in the next five to ten years.

Applications of these connected smart dust particles in the IIoT are virtually endless, from oil exploration companies spreading smart dust to monitor rock movements to small sensors all over factory equipment continually looking out for changes and problems.

At the moment smart dust sensors are still out of reach, primarily due to the difficulty in miniaturisation and the prohibitive cost of producing huge quantities. However, they are slowly but surely becoming cheaper to manufacture, so it may not be long before billions upon billions of miniscule smart dust particles populate the world.

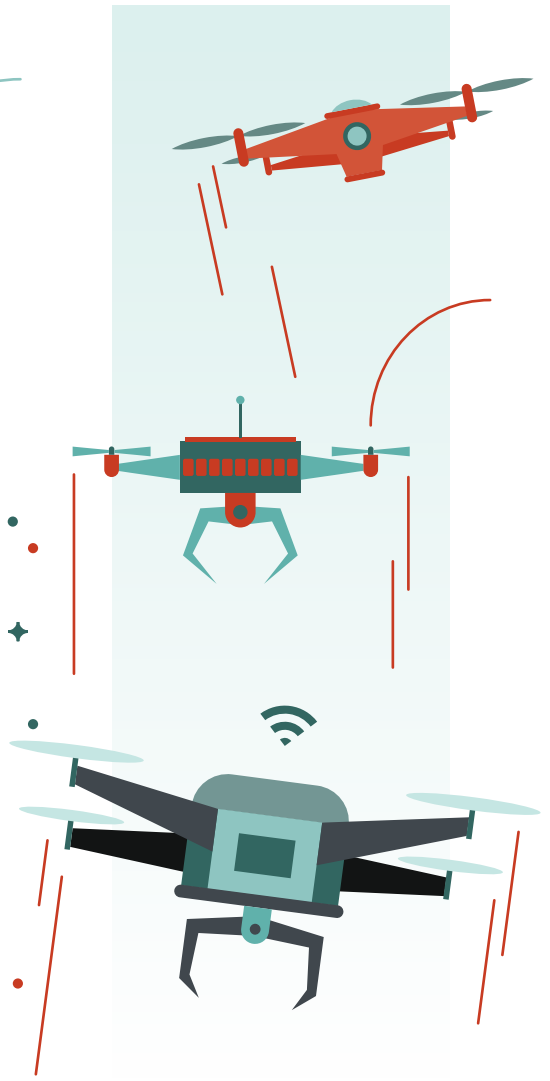
DRONES

2

Unmanned aerial vehicles, or drones, have quickly become one of the most talked about products in the tech space, thanks to their many useful applications. In the near future these machines could play a significant part in the IIoT by acting as either a sensor or by providing a connection between sensors and data collection points.

Drones may not yet be seen as a fully fledged connected IIoT device, but they can carry all range of sensors and are autonomous machines capable of gathering massive amounts of valuable data. Construction companies can use drones to undertake daily land surveys and feed this data into software to ensure construction is on schedule and send an alert if anything looks out of place or improperly built.

But drones are no mere data collectors, with the devices potentially being able to quickly act on the data they collect and communicate with other drones in the IIoT to work together to overcome problems.



FUTURISTIC FARMING

3

Far from the factory floor, in countless farms around the world, is where the IIoT could make the biggest difference. Utilising the latest technologies is nothing new for the agriculture industry, but implementing smart, connected IIoT projects enables farmers to make use of the massive amounts of data generated on their farms.

The large size of many farms makes manual surveys ineffective and difficult, leading farmers to turn to IIoT solutions. Oyster farmer Ward Aquafarms, with the help of telecoms firm Verizon, deployed an IIoT program to maximise productivity and ensure the quality of food in the supply chain, using satellite imaging and IIoT track-and-trace technology to monitor farming operations all the way from harvest to delivery.

"Agriculture presents perhaps the perfect business case for IoT implementation, so we are likely to see a much greater extension of its applications over the next five years," says Tony Judd, managing director for Verizon in the UK. "In areas like precision agriculture, real-time data about soil, weather, air quality and hydration levels can help farmers make better decisions about the planting and harvesting of crops."

AEROSPACE

Aerospace companies have mainly introduced IIoT solutions on the factory floor for tracking tools and parts, with some beginning to expand the number of on-board IoT devices. An aeroplane that knows when it's going to encounter maintenance problems before they actually happen would save a significant amount of man-hours and money for airlines.

Taleris, a joint venture by General Electric and Accenture, is at the forefront of developing IoT solutions for airlines, aimed at minimising delays and disruptions by analysing data collected from sensors on aeroplanes.

Uptake of these IoT technologies in the aerospace sector has been slow, as cost-savings are not easy to estimate, but as the benefits of these systems become apparent, interest from airlines will grow. The widespread usage of analytics programs that have the ability to monitor aircraft proactively not only improves turnaround times for airlines but also helps meet customer needs more effectively.

4

ENERGY NETWORKS

5

Energy companies can expect to see their operations fundamentally altered when IoT is fully embraced in their sector. Spikes in energy consumption around major TV broadcasts and weather events have long troubled utility firms. But with effective energy demand management through the IIoT, the need for investment in both energy networks and power plants is reduced.

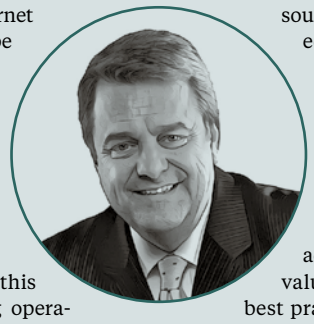
Smart meters are one example of the industry's move towards IoT technologies, although at the moment they only record usage amounts and timings. Utility firms could potentially provide price information to these meters, which could in turn interact with other IoT devices to use energy at the most efficient time.

New oil and gas pipelines are fitted with sensors that detect leaks and alert repair teams, so issues are fixed before they can cause problems and the number of blackouts and brownouts are kept to a minimum. Any improvements the IoT can achieve in energy supply management will become increasingly valuable as utility companies look for the most effective ways to deal with multiple energy sources in a decentralised network.

OPINION COLUMN

‘True connectivity is redefining businesses in nearly every vertical segment globally’

JOHN TUCCILLO
Steering committee chair
Industrial Internet Consortium



The industrial internet of things (IIoT) may be a new term to most businesses, but it is creating significantly more societal and economic value than is derived from simply “considering the cloud”.

IIoT accelerates this value by integrating operational practices, in every industry, with big data and machine-learning. IIoT affects a wide range of technologies at both the systems and device levels to include industrial automation systems, communication technology, cloud-based data analytics and related infrastructure.

While many think of manufacturing as the “industrial” in IIoT, the IIoT impact is in fact pervasive across industries, with early applications in transportation, healthcare, power, process control, buildings and smart cities.

True connectivity is redefining businesses in nearly every vertical segment globally. Connected building systems can improve power management, which enhances building safety and reliability. On a larger scale, intelligent electrical grids allow businesses to both analyse operational data for better efficiency of current plants and integrate renewable sources to support green environmental initiatives globally.

The need for connectivity and improved efficiency is paramount in creating greater value. A shift towards tighter systems integration enables enterprises to not only be more efficient, but also more profitable due to greater flexibility and responsiveness to changing conditions. Connectivity contributes to environmental sustainability objectives too.

With greater connectivity comes an accelerating need for greater cyber security practices and technologies in industrial control systems. The complexity of IIoT dictates that IIoT-focused cyber security measures be designed into business practices, automation systems and components to ensure the security of individual assets and related larger, holistic systems.

Companies that first optimise and then digitise their operations through IIoT solutions are seeing immediate value from real-time data, dramatically improving operations, creating value both within the business and for their end-use customers. When managed well, this data can apply such value as predictive analytics to stave off unplanned downtime, often identifying the sources of potential equipment issues and catastrophic risks before they happen. Companies are also benefiting from safety and security measures.

For businesses to achieve maximum value from IIoT systems, best practices are essential. The Industrial Internet Consortium (IIC) has three main objectives – build community, provide industry guidance and prove with testbeds.

Our IIC community of more than 270 companies represents today’s largest IIoT ecosystem of experts in IIoT. Stakeholders within the IIC come from every segment globally, including private industry, governments and academia. Our testbed programme is the industry’s most comprehensive, with more than 25 testbeds and growing.

We are releasing practical guidance on how to build IIoT systems. The IIC published a set of reference documents. *The Industrial Internet Reference Architecture* provides a strategic treatment of how to build an IIoT system. *The Industrial Internet Security Framework* extends the reference architecture to consider IIoT security concerns. *The Industrial Internet Connectivity Framework* provides a deep understanding of IIoT connectivity issues and best practices.

The Business Strategy and Innovation Framework provides high-level identification and analysis of issues enterprises will need to capitalise on with opportunities emerging from the IIoT. These deliverables are key enablers of IIoT, creating a roadmap for businesses to enter the IIoT ecosystem.

The potential of IIoT is to create new applications that were not possible before the combination of intelligence and networking, including innovations such as autonomous cars for safe, efficient transportation, optimised agriculture, medical devices and systems that can connect and work together to care for patients, and integrated central and distributed power generation that will transform the core infrastructure of the planet, optimising and creating industries.

These IIoT applications will be the primary economic growth drivers of the next several years. Although most IIoT systems take time to design, build and deploy, they are rapidly becoming the infrastructure for a new generation of systems benefiting both business and society mutually. As we say within the IIC, “Things are coming together.”

COMMERCIAL FEATURE

Transform enterprise operations in three simple steps...

More organisations are capturing more data while a growing number are improving their analysis of it. True value will come to those who sense, analyse and act on this data in real time, before the resulting benefits perish

ZEBRA

As they move on the football field, NFL players have carried more than just a ball over the last few seasons. The Zebra Sports Solution tracks players’ movement on the field, which enables coaches to gather performance data including speed, distance travelled, acceleration and location.

Coaches then use this data to conduct deeper analysis into formations and player tendencies. In addition, broadcasters can use it to show player statistics as part of NFL Next Gen Stats.

The Zebra Sports Solution leverages the same identity, tracking and location technologies that strategic enterprise internet of things adviser Zebra Technologies implements globally for multinational corporations in healthcare, retail, manufacturing, and transportation and logistics to give real-time visibility to an organisation’s assets, people and processes.

“Sensing technology has delivered huge benefits to enterprises globally, especially when the data created by those sensors is analysed effectively,” says Zebra chief technology officer Tom Bianculli. “But all too often this data is used to generate reports or statistics long after it can be used to impact operations in the moment. We are now entering a new phase in which we’re helping a wide range of organisations to act on their data in near real time. Today it’s about sensing and analysing, and then taking that next best action right at the point of activity whenever and wherever possible.”

For example, Zebra is helping retailers to gain greater visibility of their stock and their customers, and to act based on that new digital picture. “Big data is essential for longer-term forecasting and our technology takes full advantage of what it offers,” says Mr Bianculli. “And we help organisations to use small data as well. Just as coaches can use the data they receive from the field of play, retail sensor tags can sense that a display of jeans in a shop is down to its last three pairs. The system can then trigger a workflow to have another dozen brought up from the stock room in minutes.”

To help retailers co-ordinate the information available to them and make the best use of it, Zebra Technologies recently launched SmartSense™ for Retail. This solution turns an entire physical store into a smart online store by automatically sensing and recording the location and movement of virtually everything in the space, including merchandise, staff, shoppers and products.

> We are now entering a new phase in which we’re helping a wide range of organisations to act on their data in near real time

“For example, sensor tags can indicate how much of which stock is available while video analytics can identify merchandise and people in motion, and all of that sensor data can be fused together to identify the next best action for store associates. Whether that be aiding a customer looking to make a purchase decision or being dispatched to replenish a shelf with stock from the back room,” says Mr Bianculli.

Enabling employees to act quickly and easily with this data enables companies to gain a competitive edge and deploy their valuable resources most effectively. “In healthcare, a smart wristband informs the hospital system of the location of patients which, when combined with other data sources, can be used to enhance the care-flow journey, reducing waiting times and errors, and improving patient care and throughput,” he says.

“Technology is creating an ocean of data that, with the advent of machine-learning, can be distilled down to actionable insight not just for managers but for every employee. However, it’s not just about quantity of data anymore. Today the important aspect is how quickly and easily you can turn that data into real-time, actionable information that allows you to make smarter business decisions which result in operational and customer-experience benefit.”

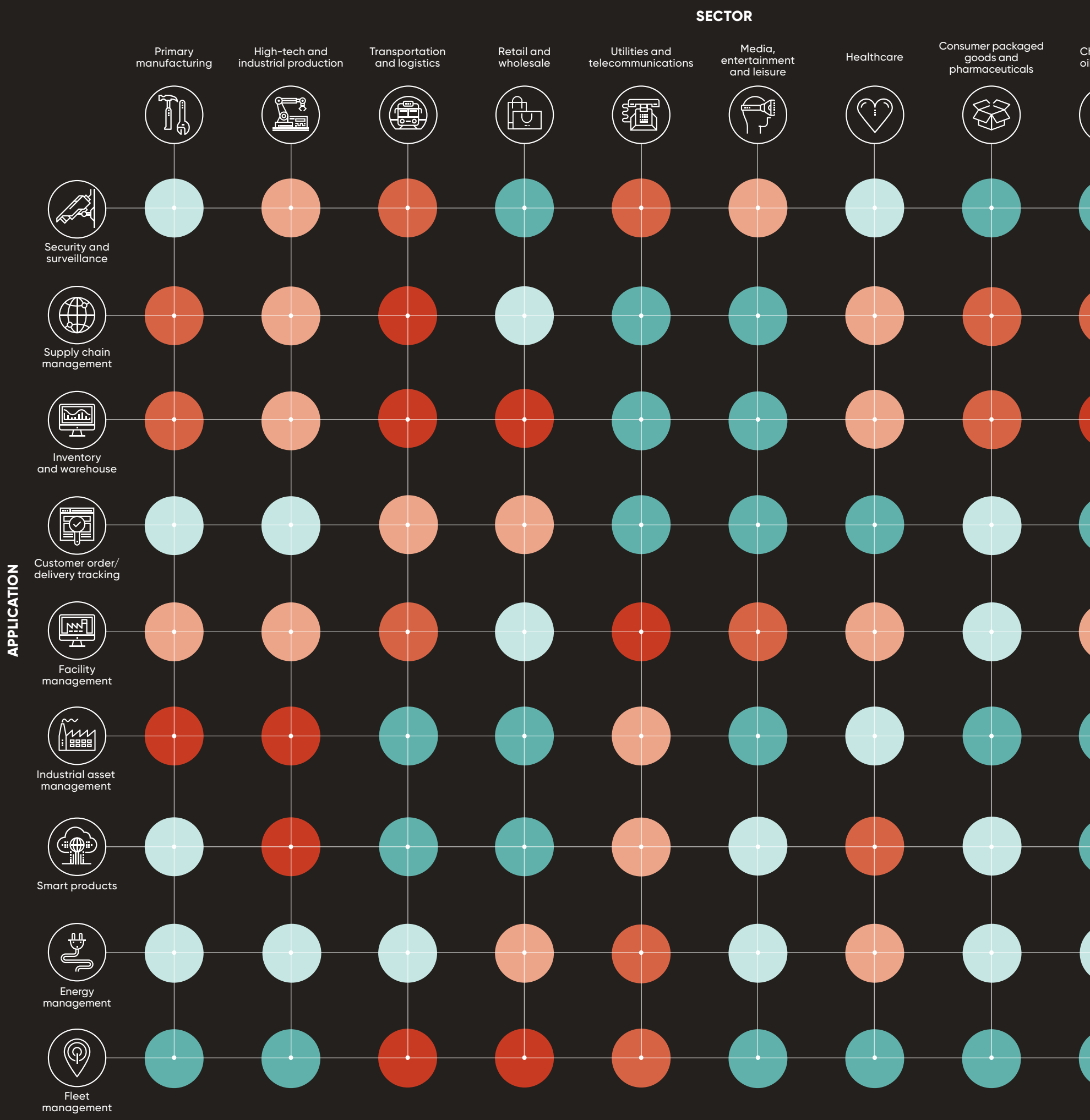
For more information please visit www.zebra.com

CONNECTED CAPABILITIES

The internet of things (IoT) has the potential to transform almost every function of every industry, from retail and healthcare to t
Here are the sectors and countries leading the charge

IoT OPPORTUNITIES BY INDUSTRY AND APPLICATION

RANKING OF OPPORTUNITIE



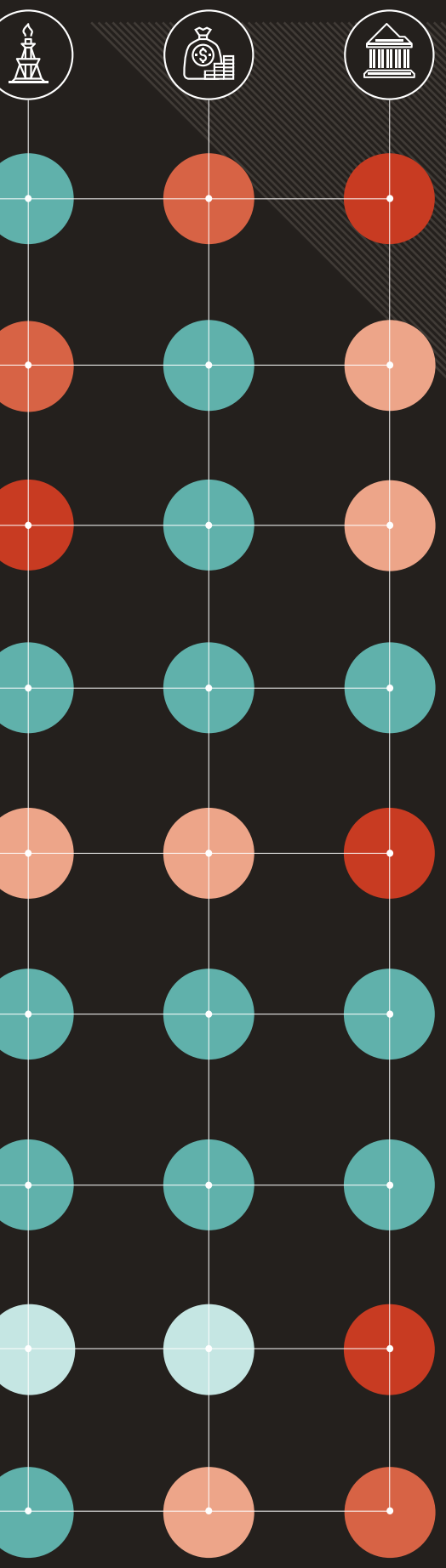
ransportation and oil and gas.

ES Cool Warm Hot Hotter Hottest

hemicals, l and gas

Financial services and insurance

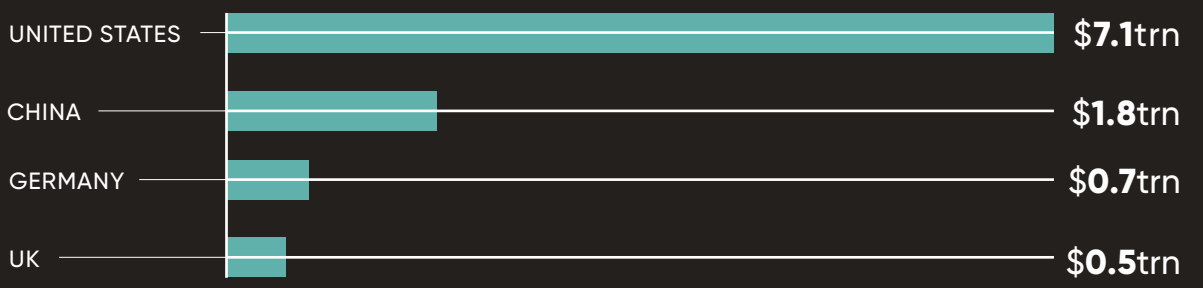
Government, education and social services



Forrester 2016

VALUE OF INDUSTRIAL IoT IN 2030

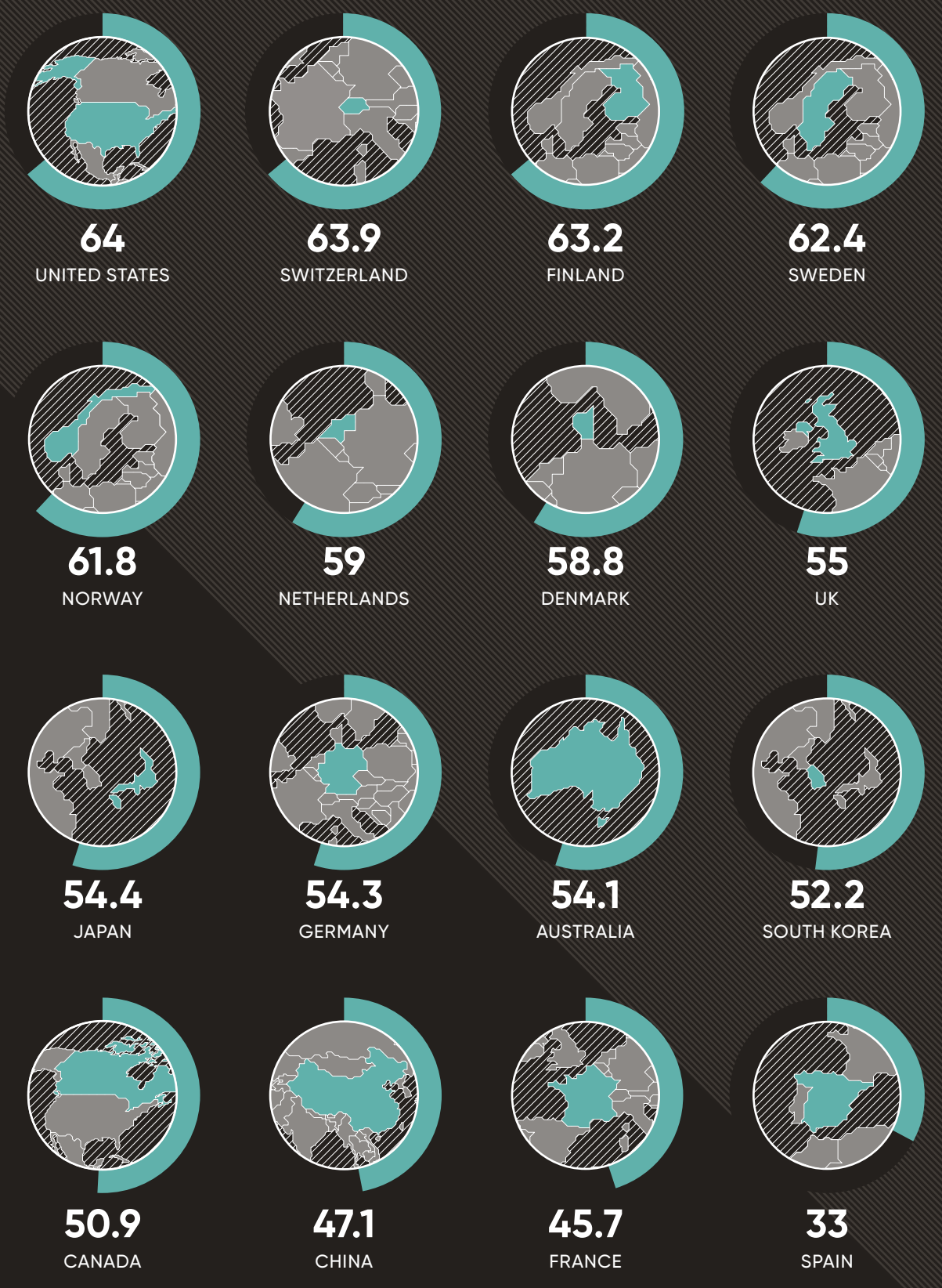
WHAT INDUSTRIAL IoT COULD BE WORTH TO THE FOLLOWING ECONOMIES



Accenture 2015

INDUSTRIAL IoT ENABLING FACTORS BY SELECTED COUNTRY

EACH COUNTRY IS RANKED BY ITS NATIONAL ABSORPTIVE CAPACITY, SCORED OUT OF 100, BASED ON A NUMBER OF SOCIAL, ECONOMIC AND POLITICAL ENABLING FACTORS



Accenture/Frontier Economics 2015

SECURITY

Too many loopholes for cyber criminals

Inadequate security remains a concern with the industrial internet of things as the number of cyber attacks continues to rise

WENDY M. GROSSMAN

"All we need is for one of us – just one, sooner or later – to have the thing we're all hoping for... one... good... day." Fans of the hit TV series *Buffy the Vampire Slayer* may recognise that – it's the vampire Spike explaining to Buffy why her life expectancy is irredeemably short. It also serves as a metaphor for cyber attackers and IT systems – there are an untold number of them and one of you, and all they have to do is have one good day.

Protecting the industrial internet of things requires a mental shift from protecting enterprise IT. With enterprise IT, the biggest threat is typically to data that may be exfiltrated, deleted, rendered inaccessible – as in ransomware – or published. With industrial control systems, the threat shifts to physical damage.

"I don't think these threats are over-hyped," says Chris Hankin, the Imperial College London professor who leads the multi-university Research Institute for Trustworthy Industrial Control Systems.

He cites statistics from the US-based Industrial Control Systems Computer Emergency Response Team (ICS-CERT), which show a steadily increasing number of incidents over the last five years. Their 2015 report tallied 295 reported incidents and, while that's a small number compared to today's near-daily headlines about data breaches, the examples he cites are scary enough.

> When you put operational technology into the cloud or connect in any way to the internet you have a problem

The earliest example dates from 2000 in Australia, when an attack on Maroochy Shire Council's computerised waste management system caused millions of litres of raw sewage to spill into rivers, parks and hotel grounds. In 2015 and 2016 Charlie Miller and Chris Valasek showed they could use a Jeep Cherokee's internet connection to immobilise it remotely on a highway, cause unintended acceleration, slam on the brakes and turn the steering wheel.

Professor Carsten Maple, of the University of Warwick's Cyber Security Centre and the PETRAS Internet of Things Research Hub, adds a few more such tales. In 2014 the German Federal Office of Information revealed that an attack caused millions of pounds worth of damage by overheating the furnace in a German steel mill.

Last year a ransomware attack spread across the computers belonging to San Francisco's municipal transportation system; rather than pay the $73,000 the attackers demanded, staff opened the gates and allowed passengers to ride for free for two days while they restored the system from backups.

Also last year a former employee used a virtual private network to breach Georgia-Pacific and reach one of its paper towel factories, costing an estimated $1.1 million in lost or spoiled production.

In both 2015 and 2016 attacks on substations turned off power to tens of thousands of Ukrainian households. And let's not forget Stuxnet, which attacked computer controls over the centrifuges used to refine uranium within Iranian nuclear facilities, damaging them and the country's nuclear programme. As harbingers of things to come, none of these is trivial.

> It's surprising how lax some very big manufacturers are about their products

"If you look at the ICS-CERT annual report," says Professor Hankin, "the major sector experiencing cyber incidents until 2014 was energy. Then in 2015 the largest was critical manufacturing, though energy was still quite big."

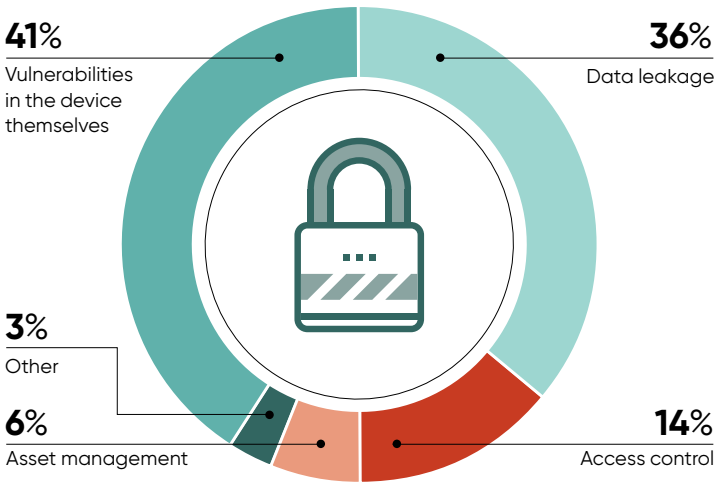
Scott Lester, principal researcher at Context Information Security, comments: "From our experience, all traditional manufacturers are struggling to keep up." The desire for speed to market is a key issue, but he adds: "It's surprising how lax some very big manufacturers are about their products. People aren't even thinking about existing threats." And, as Spike said, it just takes one successful exploit.

A key element, says Professor Maple, is understanding that in terms of security it's not helpful to think separately about operational technology, such as industrial control systems and enterprise IT. In many cases, such as the Jeep Cherokee, they may be linked because of poor design which failed to implement sandboxing to segment the driving system from the entertainment system. In others, changes over time may open up undocumented connections.

Professor Hankin agrees: "Almost all of the case studies we know about seem to have started off with some compromise of the enterprise IT system as a way of getting to the industrial control system." The anatomy of the attack is a bit different when a hybrid cyber-physical system is involved and the goal is substantially different, but separating them is meaningless when the vector for infection for something as sophisticated as Stuxnet begins with a phishing e-mail.

The issue of safety adds complexity because one of the first things security people will tell you is to ensure that everything is patched and up to date. But, as Professor Hankin notes, changes to software should trigger a safety recheck, a much more expensive process and one companies do not typically expect to undertake with anything like the frequency of today's software patching.

MOST SIGNIFICANT IoT SECURITY CONCERNS FOR UK ENTERPRISES



ISACA 2015

Worse, he adds, sometimes the two are in conflict. As a simple example, consider a tube station where something has gone wrong. Security might dictate closing the barriers and keeping people in, while safety might dictate opening the barriers to let them out.

None of this is to downplay the usefulness of the industrial internet of things in terms of improving efficiency, reducing waste and adding flexibility. What's crucial is to be aware of the security issues that come with adding communications capabilities to legacy systems.

This will be even truer as consumer-grade internet of things devices penetrate previously manual factory areas. Even if the systems themselves are air-gapped, workers in those areas may be wearing personal health monitors, smart watches or augmented reality headgear and, of course, everyone might be carrying a smartphone.

"When you put operational technology into the cloud or connect in any way to the internet you have a problem," says Professor Maple. "You have to do a proper threat assessment. Does it give you benefit, are you aware of all the risks?"

Saverio Romeo, principal analyst at Beecham Research, recommends assuming the worst will happen, and developing strong remediation systems so you can recover quickly and safely. He also stresses the importance of designing in security from the beginning.

In response to the exploits Miller and Valasek, Fiat-Chrysler eventually recalled 1.4 million cars, which was surely more expensive than starting with a sandboxed design that separated the automotive control systems from the entertainment systems.

"Retrofitting is economically very expensive and difficult to do," says Mr Romeo. "Design of a connected system requires proper security strategy, which includes the ability to remediate." He recommends consulting the guidelines published by the European Cyber Security Group, Internet of Things Consortium and Industrial Internet Consortium. To that list Professor Hankin adds the National Institute of Standards and Technology and the UK's National Centre for Cyber Security.

VolhaHanna Kanashyts/Shutterstock

Jeep's owner Fiat-Chrysler recalled 1.4 million Cherokee vehicles after hackers showed they were able to use its internet connection to immobilise the car remotely on a highway

COMMERCIAL FEATURE

Devising a common language so that things can 'talk'

The dream of an internet of things could turn into a nightmare without a common language to avoid it being drowned out by a babel of voices connecting billions of devices

In the rush to develop the internet of things (IoT), device makers have focused on how their own products get online and there has been little standardisation.

The danger is that the default solution is to have complex hardware and software systems that require a central unit to act as both controller and translator, often relying on the cloud to link devices that are just a few metres apart.

Lemonbeat believes there is an alternative and has devised a universal software framework – a set of building blocks or services – for microcontrollers that allows users to develop smart devices swiftly and easily. A common language enables those smart devices to interact with each other directly and independently, allowing the IoT to operate as simply and effectively as possible.

The benefits of direct device interaction are increased speed, reduced need for infrastructure, less disruption from internet downtime and high levels of security.

This ability to bring intelligence out of the cloud and on to even the simplest devices – sometimes referred to as an edge-based solution – eases the burden on the network and accelerates the performance of the whole system.

The ability to adopt a common language has huge implications and potential benefits for a wide range of applications, including smart homes, smart buildings, smart energy and industry 4.0.

Started in 2015, Lemonbeat is a subsidiary of European energy group innogy. It calls its language Lemonbeat Smart Device Language (LsDL) and even though it boasts that it is groundbreaking, it believes it will prove popular because it is based on the XML language familiar to programmers and developers.

The technology is already used in the SmartHome product range of Innogy, and in the garden watering systems and robot lawnmowers made by Gardena.

This year Lemonbeat announced a collaboration with electrical components maker Phoenix Contact to work on building automation technology, with a focus on reducing the amount and complexity of hardware to increase efficiency and bring down costs.

Other areas where it sees a take-up in the near future include smart meters for utilities and electric vehicle charging points.

Lemonbeat managing director Oliver van der Mond likens their concept of universal building blocks to the genotype or working instructions that living organisms carry. "It's like the DNA for the IoT. Communication is controlled in a decentralised manner, similar to a biological organism," he says.

To make sure devices can communicate, it can be used on LoRa, wi-fi and ethernet networks, but the company has also developed its own Lemonbeat Radio product for transmitting on the sub-GHz radio spectrum on which many IoT devices will run. In general it uses standard internet technologies such as IPv6.

It consumes very little energy, so is particularly useful for so-called constrained devices such as sensors that rely on battery power.

Lemonbeat is determined not to work on the development of its framework in isolation and is keen to fuel a debate on how a common language can be used to the benefit of all users of the IoT, from manufacturers of devices and equipment, to commercial building managers and production line operators.

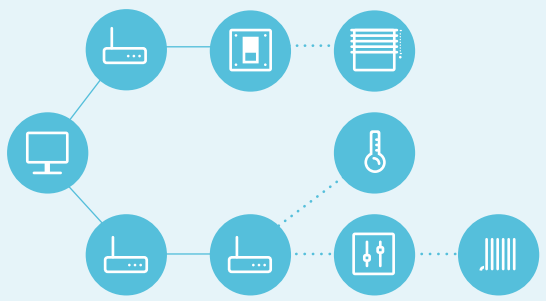
It is working with Web of Things Interest Group, part of World Wide Web Consortium (W3C,) to develop a common web standard and is a member of Europe's EEBus initiative to focus on standardisation in the IoT across sectors including energy, homes and buildings, and connected devices such as domestic appliances.

Mr van der Mond concludes: "A common standard for developing smart things for the IoT will serve users better, just as HTML does for building websites. We think it is important to collaborate so that we can share our know-how and expertise with others. Therefore, we engage with partners across a wide range of backgrounds."

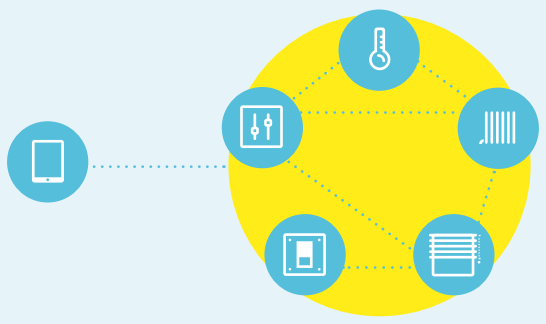
For more information please visit www.lemonbeat.com

IoT NETWORK ARCHITECTURE

Current classical network architecture
Incompatable, isolated, inflexable, expensive, insecure



Future IoT networks
Interoperable, intergated, adaptive, low-cost, secure



HEALTHCARE

Connected tech is just

There are an extraordinary number of applications in healthcare for the internet of things which will eventually be at the heart of patient care delivery

MARTIN BARROW

Healthcare systems all over the world are struggling with two fundamental concerns – how to afford the rising cost of delivering care and how to integrate ever-changing new technologies?

These twin challenges are intrinsically connected, for emerging technologies offer the promise of making care more affordable as well as more effective. The rewards for successful implementation will be significant, for patients as well as for those responsible for the sustainability of healthcare systems.

In healthcare, the internet of things (IoT) is changing the way we think about looking after people. At the heart of this technological revolution is a focus on connectivity. Drug discovery and greater understanding of disease are critical. But these must go hand in hand with the way we exploit information and data, using internet-connected devices to process and inform the way we manage care.

The scale of investment underway in healthcare IoT is colossal. MarketResearch.com, the markets intelligence specialists, estimate that globally investment could reach $117 billion by 2020. North America will continue as the most significant market, with rapid growth on the back of the region's advanced healthcare infrastructure and increased levels of research and development initiatives in IoT.

But, increasingly, the Asia-Pacific region looks to be an exciting market, supported by strong economic growth and rising disposable income, together with the emergence of IT-enabled healthcare services and the penetration of smartphones and wearable medical devices.

CASE STUDY

HELPING WITH DEMENTIA

The internet of things is being deployed to improve the lives of people with dementia. A project has been launched in Surrey and North-East Hampshire to test how technology can help them remain in their homes for longer.

The Technology Integrated Health Management project will provide people with dementia and their carers with sensors, wearable technology and other devices to monitor their health at home. These devices can, for example, detect if someone has left the house, had a fall, is not eating or drinking normally or has used the bathroom more than usual. If the technology identifies a problem, an alert is issued that is followed up by a clinician or carer.

The two-year project will involve around 700 patients and their carers, with a view to scaling IoT for dementia across the area's 1.3 million population. Almost 250 people have come forward so far, with another 50 homes a month expected to be added through 2017.

Dr Helen Rostill, director of innovation and development at Surrey and Borders Partnership, who leads the study, says: "It is clear that people are desperate for a new approach to help support them to manage this condition and can already see how this study can benefit them."

Ray Ledge, a carer from Farnham who looks after his wife Carol, adds: "The greatest thing about this study is it could develop into something very positive for the future and will give the medical community greater insight into the condition."

the thing for the NHS

Reza Estakhrian/Getty Images

CONNECTED HEALTHCARE

13k+

additional healthcare jobs expected to be created in the UK from 2015 to 2020 as a result of IoT

£4.8bn

estimated economic benefit to UK healthcare from the use of IoT between 2015 and 2020

SAS Institute/Cebr 2016

It is a huge number, but consider the extraordinary range of IoT applications in healthcare, encompassing systems and software, medical devices and services. The IoT in healthcare market includes implanted, wearable and stationary medical devices used in clinical research and by diagnostic laboratories, hospitals and medical centres.

In the healthcare industry, IoT has a wide range of applications, including clinical operations and workflow management, in-patient monitoring, telemedicine, connected imaging and medication management. Bluetooth low energy, ZigBee, satellite, wi-fi, near-field communication and cellular are some of the key connectivity technologies involved in IoT in healthcare.

One of the biggest challenges is how to connect this vast amount of health information, which is scattered and siloed, and make it accessible, using a common language that can understood and trusted by all.

At a very personal level, you may find the information you collect and hold via an app on your mobile phone about your lifestyle or the management of a health condition may be admired by your GP, but he probably has to conduct his own tests because the data is unlikely to be compatible with information systems, or considered to be a trusted source.

At a global level, healthcare providers, payers and manufacturers are often seeing a different version of the healthcare universe, which takes them in different, and sometimes conflicting, directions. Overcoming this incompatibility is critical. For example, a connected healthcare ecosystem that spans from research and development through to commercialisation and treatment adherence could be just the solution for life sciences companies and payers seeking to demonstrate value from new treatment outcomes.

An ecosystem in which patients can harness data from diverse connected devices will create a deluge of new data. Healthcare practitioners will be able to monitor a patient's health, activity and reaction to treatments in real time. If a patient suffers a cardiac event or hypoglycaemic episode, for example, data can be used by the specialist to take immediate action.

This can include elements that are often out of the view of treating physicians, such as dietary information, which may impact outcomes. These indicators have a cumulative impact on the outcome derived from standard medical interventions. So, for the first time, healthcare systems will have a complete picture and be able to optimise treatments and environments for better outcomes.

> The internet of things is changing the way we think about looking after people

The significant amount of data generated by a connected ecosystem can also influence the future trajectory of research and development. Real-world evidence provides significant insight into how a drug or drug class performs, or is used in real-world medical settings. The ability to transform real-world data sources quickly into evidence can improve health outcomes for patients by helping pharmaceutical groups be more efficient in drug development and smarter in commercialisation.

Is the NHS able to capitalise on IoT? It is one of its biggest challenges as UK health authorities take steps to reconfigure the health service to make it affordable and sustainable. Last year's Wachter *Review of Information Technology in the NHS* said creating a fully digitised health service was likely to be the most difficult reform. The NHS has a toxic legacy of IT failures, particularly in the hospitals sector where, tantalisingly, the potential for IoT transformation is greatest.

Robert Wachter, who led the review, advised that it was better to get digitisation right than to do it quickly. Return on investment should also be measured in terms of improvements in safety and quality, with cost-savings likely to take ten years or more to emerge.

One of the review's recommendations was hospital trusts that were ready to digitise should be prompted to do so, with others encouraged and supported over a number of years. The result is NHS England's Test Beds Initiative, launched in January 2016 with evaluation likely to take up to three years.

Two of the seven test beds are focused on IoT and form part of IoTUK, an integrated £40-million government programme that seeks to advance the UK's global leadership in IoT. These comprise a diabetes digital coach, a project led by the West of England Academic Health Science Network in partnership with Diabetes UK and technology companies including Hewlett Packard and Technology Integrated Health Management, a collaboration between Surrey and Borders Partnership NHS Foundation Trust, and an array of health technology providers which will help people with dementia to live in their own homes for longer.

The devolved nature of the NHS in England means trusts are free to pursue their own IoT developments. The aspiration is that as systems become embedded, they will be adopted and implemented by other trusts. This approach will reduce the risk of repeating the major IT infrastructure failures of the past. What is certain is, sooner or later, the internet of things will be at the heart of the delivery of care across the NHS.

AUTOMATION

The sun is rising in the East

The West is playing catch-up as manufacturers in the Far East race ahead with the industrial internet of things, delivering a competitive edge through advanced factory automation

JIM McCLELLAND

Heralding a new dawn of digital disruption, the industrial internet of things (IIoT), like the sun, is rising in the East. For manufacturing, its application is opening up hot prospects and prompting something akin to a global tech gold rush. Opportunity beckons and the race is on.

It is not, however, a race Europe currently leads, Daniel Keely, manufacturing director, Europe, Middle East, Africa and Russia, at Cisco's manufacturing practice digital transformation group, concedes. "Manufacturing is undoubtedly a key engine for growth across Europe, with more than two thirds of all EU exports coming from the sector. However, in some critical aspects of digital innovation, Europe is lagging behind its Asian competitors," he says.

IIoT is transforming manufacturing in Asia, right now, delivering dynamic competitive advantage, IBM internet of things (IoT) distinguished engineer Andy Stanford-Clark concurs. "We are seeing a huge take-up of advanced factory automation in the Far East, particularly in China and Taiwan. They are realising the efficiency benefits that can be gained by the use of general purpose robot arm technology on a production line."

Rather than designing and building a complex piece of machinery specifically for the purpose of a particular task, manufacturers can take an off-the-shelf six-axis robot arm and program it to suit. With the advent of software-defined hardware, the same robot arm can then be deployed to a different task, just by reprogramming it, making production fast, cheap and agile.

> We are seeing a huge take-up of advanced factory automation in the Far East, particularly in China and Taiwan

Industrial complex near Mount Fuji in Shizouka City, Japan

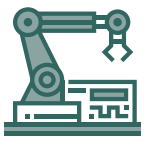
Advances in other areas as seemingly mundane as maintenance can also build a business case for IIoT, adds Mr Stanford-Clark. "Predictive maintenance, combined with traditional schedules, enables expensive downtime to be minimised and elimination of certain fault conditions. Savings due to predictive maintenance have on their own justified companies' investment in IIoT," he points out.

Western firms are keen to cash in on these emerging export opportunities, not least in the East. GE, for instance, has been creating what it calls digital foundries, starting in California then opening in Paris and Shanghai.

While the rate of growth might be slowing in terms of sheer output, the scale of industrial activity in China still represents a huge attraction for global tech players.

China remains the world's largest manufacturer and also leads on connected things. Accenture estimates that fully embracing IoT in manufacturing could deliver economic value up to $736 billion in total for the period 2015 to 2030.

Tomohiro Ohsumi/ Bloomberg via Getty Images



82%

of manufacturers that have implemented smart manufacturing technologies have seen an increase in efficiency

Motorola Solutions 2017

With a strategy dubbed Made in China 2025, the country's serial five-year plans are already prioritising advanced automation with a vision of becoming the world leader in precision manufacturing by 2050. Behind this trend actually lies a dynamic shift in the nature of work, as China faces up to the challenge of transitioning away from a business model based on cheap labour, says Mr Stanford-Clark.

He says: "Part of this initiative is to enable human workers, engaged in what are referred to as the 3D – dull, dirty, dangerous – jobs, to move to more fulfilling and less monotonous roles, often working alongside 'people-safe' or 'compliant' robotic devices."

So with evidence for efficiency and agility mounting in the East, why is Europe not accelerating progress on IIoT to match?

It is not that Europe does not understand the threat of disruption and need for innovation, argues Mr Keely. "Countries across Europe are undoubtedly adopting IIoT technologies and responding to the challenge of digital disruption in proactive ways," he says. "The Industrie 4.0 or i4.0 incentive is an example being driven by the German government together with manufacturers such as Bosch and Siemens, while the UK Industrial Strategy places digital at the core of manufacturing."

The problem is their global competitors simply threaten to outpace them. There is a steep learning curve, says Mr Keely. "While some European manufacturers have begun to connect industrial machines on the plant floor, sharing data among makers, end-users, third parties and so forth is complex. One reason is proprietary protocols, which hinder interoperability," he says.

"Additionally, in Europe, many manufacturers are small and medium-sized enterprises that lack some of the broader digital capabilities that will be critical moving forward."

There is, though, cause for optimism around IIoT uptake in Europe, contends Andrew Minturn, business development and strategic product manager at Bosch Rexroth. "It's picking up speed with major manufacturers now looking to adopt the cyber-physical systems approach to productivity," he says. "Hardware and software are connected to ensure we can react quicker to product-mix one-offs, with improvement in quality and costs, also delivery.

"We are starting to see the connected value stream which ensures products are delivered at the right time, at the right place, and in the right type and quantities. Uptake will increase tenfold in the next few years."

Rather less convinced about uptake is Frank Piller, professor of technology management at RWTH Aachen University, Germany. "We see plenty of pilots and little large-scale deployment," he says. "The number of truly digital, data-driven factories is very low. In Germany, leaders like Siemens with the Amberg factory, or Festo with the Scharnhausen plant, show what can be possible."

Professor Piller, who heads up the Leading the Smart Factory of the Future programme, identifies standardisation as an area that has been holding back progress with what he describes as a "zoo of competing industry, public and company standards".

However, this is one roadblock that is about to be removed. Finally, Europe and America are co-operating on a major cross-industry initiative with the launch by German industry of Standardization Council i4.0. "This will become a game-changer and enabler," Professor Piller concludes.

Q&A Connectivity at the heart of the internet of things

It's well known that the internet of things is enabled by innovation from large chip makers in the United States and Asia. Less known, however, is the small British firm working with them. **Mike Sims**, chief executive at LM Technologies, reveals how his company is shaking up the market

Why is connectivity so vital to the industrial sector in coming years?
The number of devices connected to the internet of things (IoT) continues to grow rapidly. According to Ericsson, it is growing at a rate of 23 per cent annually and of the 28 billion devices it predicts will be connected by 2021, 16 billion will be IoT devices. For the industrial sector to take advantage of that, strong connectivity is critical. The IoT encompasses many technologies, but wi-fi and Bluetooth will account for a massive portion of the estimated market. As a Qualcomm manufacturing partner, LM Technologies is in the right position to take advantage of the IoT growth due to the range of integrated circuits (ICs) supported by the chip maker. We also have access to other chip makers, such as Cypress Semiconductor and Realtek, offering our company a wide selection of chipsets focused on Bluetooth and wi-fi technologies.

What is the most suitable IoT development option for industrial companies?
LM offers a very high level of development support to its customers to ensure they are aware of the options available. With our close ties to the IC vendors, we tend to work with early-silicon and are designing products with ICs that are not yet in the market. This year we release the world's first dual mode module embedded stack using Qualcomm's CSRb534x range of ICs, keeping our research and development focus at the very forefront of the latest technology.

What new innovations are in the pipeline in this space?
With our first Qualcomm Atheros-based module, we are aiming to offer a sub-$10 wi-fi module with its own editable stack, which we see as the perfect platform for customers' application development. Being the only Qualcomm Atheros module partner in Europe, we believe our new Atheros-based range of modules will enable multiple IoT companies to advance their products' capabilities. All the Atheros chipsets are -40C rated and offer low-power consumption. This year, LM will also release the first Bluetooth 4.1 serial adapter, which will be able to communicate with Apple devices without the need for an Apple authentication chipset, negating any Apple product commission. The current EPOS market is using more Apple devices than ever before and being able to interface with non-Apple authentication devices is key to expanding the device choice in this market.

What competitors do you have in Europe?
There may be several other wireless module companies, but LM's links with IC vendors and the customer-supported design process we offer is unique in Europe. Some similar companies may have access to one or even two of the top IC vendors, but no other company has the same ICs within their modules. We are also the only company to offer customers a dedicated solutions team that supports them throughout the life cycle of their product.

> LM offers a very high level of development support to its customers to ensure they are aware of the options available

Why is energy efficiency so important to wi-fi connectivity in the industrial IoT?
While the IoT includes devices across all wireless platforms, the majority of IoT devices are battery powered. Therefore, energy consumption is a key factor when companies are selecting the technology for their IoT device. A good example of the difference that LM offers is within one of our recent developments, where we developed a key fob that needed to send data to a connected device every two seconds. The customer wanted the product to last 12 months using only a 200mA coin cell battery and initial testing indicated it wasn't possible. However, our team's application development was able to reduce consumption beyond the original design parameters of the chipset to meet the customer's specification. This development epitomises the close customer collaboration that stands LM apart from its competitors, as well as our commitment to customers' target specifications.

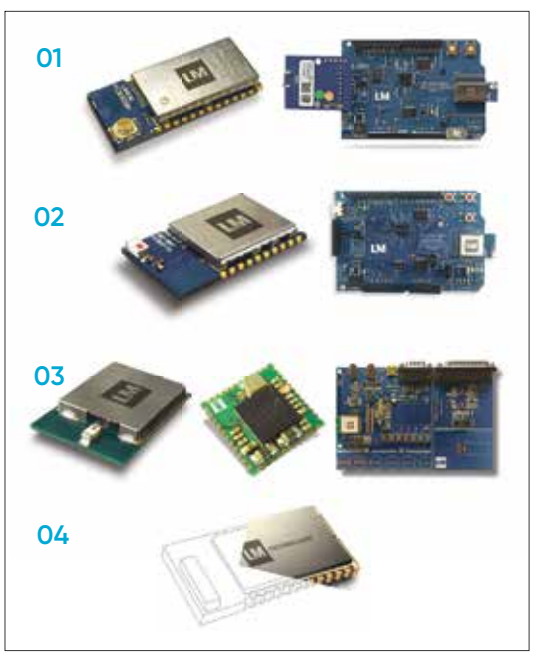
For more information please visit www.lm-technologies.com

01 Bluetooth **4.1** Low Energy GATT **LM93x Series**

02 Bluetooth **4.1** Dual Mode SPP GATT **LM96x Series**

03 Bluetooth **4.0** Audio A2DP, HSP, PBAP, SPP HFP **LM74x Series**

04 Qualcomm-Based Wi-Fi & Bluetooth - Low Energy Modules Coming Soon



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